THE INSTITUTE OF PAPER CHEMISTRY
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END-LOAD COMPRESSION STRENGTH OF TAPE REINFORCED BOXES

Project 1108-4 - Report

SUMMARY

It was found that the end-load compression strength of an RSC box was increased by as much as 12% by reinforcing the outer flaps with 1/7 of a cent worth of paper tape.

DISCUSSION

Allied studies of top-load box compression have shown that compression strength can be increased by about 16 to 19% by applying a single thickness six inches wide of a 60-lb. kraft gummed tape to the vertical edges of the box. A brief study was carried out on end-load compression of boxes which were reinforced with a 60-lb. kraft gummed tape.

A sample of boxes with dimensions 16x12-1/4x9-1/2-in., with a taped manufacturer's joint, made from an A-flute, 200-lb. series board, was used for this study. Five boxes were tested for each condition.

Reinforcement was applied to the flap panels of the box--i.e., the panels composed of flaps. Motion pictures of failure of RCS boxes in end-load compression show that, in most cases, failure is initiated in the single-face liner of the outer flaps at the middle of the panel where the outer flaps meet, and progresses outward to the "vertical" edges (1). Reinforcement of these flap panels was achieved by placing tape on the single-face liner of the outer flap, as illustrated in Fig. 1. Four tape widths were used: one-quarter, one-half, one, and two inches in width. The same roll

of tape was used for all conditions--a three-inch, 60-lb. kraft gummed tape which was cut to the desired width for each condition. The tape was placed on the single-face liner of each of the outer flaps so that it coincided with the flap edge and extended across the area between the inner flaps and about one-half inch beyond the edge of the inner flap.

In addition to the method of reinforcement described above, one sample of boxes was prepared with the three-inch tape placed along the "vertical" edges on the outside of the box. The tape extended the full length of the outer flap with one and one-half inches of tape on the flap panel and one and one-half inches of tape on the side panel. A sixth sample was the control with no tape reinforcement on the box.

All testing was carried out in a 50 ± 2% R.H. and 73 ± 3.5° F. atmosphere on a Baldwin-Southwark Universal test machine at a loading rate of 0.5 in./min.

Table I shows the results obtained in this study.

TABLE I

TAPE REINFORCEMENT OF END-LOAD BOXES

Location of Reinforcement	Number of Specimens	Compression Load, lb. Average	Range	Diff., %[a]	Deflection at Maximum Load, in.	Cost/ Box, cents
Control (no reinforcement)	5	647	586-690	--	0.326	--
One-quarter inch, mid-panel	5	648	572-710	+ 0.2	0.298	0.02
One-half inch, mid-panel	5	694	664-714	+ 7.3	0.324	0.04
One inch, mid-panel	5	662	624-750	+ 2.3	0.330	0.08
Two inches, mid-panel	5	725	658-810	+ 12.1	0.346	0.15
Three inches, vertical edge	5	705	640-770	+ 9.0	0.328	0.80

[a] Diff., % based on control

The data in Table I indicate that an increase in end-load strength of the boxes was achieved by reinforcing the flap panels and vertical edges with tape. With reference to the tape reinforcement at the mid-panel of the flaps, it is found that, except for one inversion, the per cent increase in box-load went up as the width of reinforcing tape was increased, starting at 0.2% for a quarter-inch strip and reaching a maximum of 12.1% for a two-inch strip. The inversion was with the one-inch width which showed an increase over the control but was less than the increase in load of the one-half inch strip of tape (+2.3 and +7.3%, respectively).

The reinforcement of the vertical edges (i.e., vertical in the end-load orientation) of the box, using a three-inch wide strip of tape, gave a 9.0% increase in end-load compression relative to the control sample. The question might be raised: if failure initiates in the outer flaps at mid-panel and extends to the vertical edge, why does reinforcement of the edges increase box load? This might occur in the following manner. First of all, it is assumed that the failure occurs because of bowing of the flap panel. Secondly, as shown in Table I, it will be found that the deflection at maximum load is about the same for the control sample as for the edge-reinforced sample. Thus, failure can occur in the same manner for both samples; however, due to the reinforcement, greater load is supported at the vertical edges at the time the same deflection is reached in the reinforced box as compared to the control box.

On a cost basis, as shown in Table I, the tape reinforcements of the mid-panel range from two hundredths to fifteen hundredths of a cent going from a quarter-inch to two-inch wide tape. The cost of reinforcing the vertical edges was about eight-tenths of a cent.

This brief study of reinforcing end-load boxes with tape shows that a gain in box load can be achieved by this method. Further investigation may be

warranted to determine the effect of: (1) a combination of edge and mid-panel reinforcement: (2) reinforcement by wax treatment for standard and high humidity performance.

Literature Cited

1. The Institute of Paper Chemistry. End-Load Box Compression. A preliminary report to the technical committee of the Fourdrinier Kraft Board Institute, Inc. August 20, 1963.

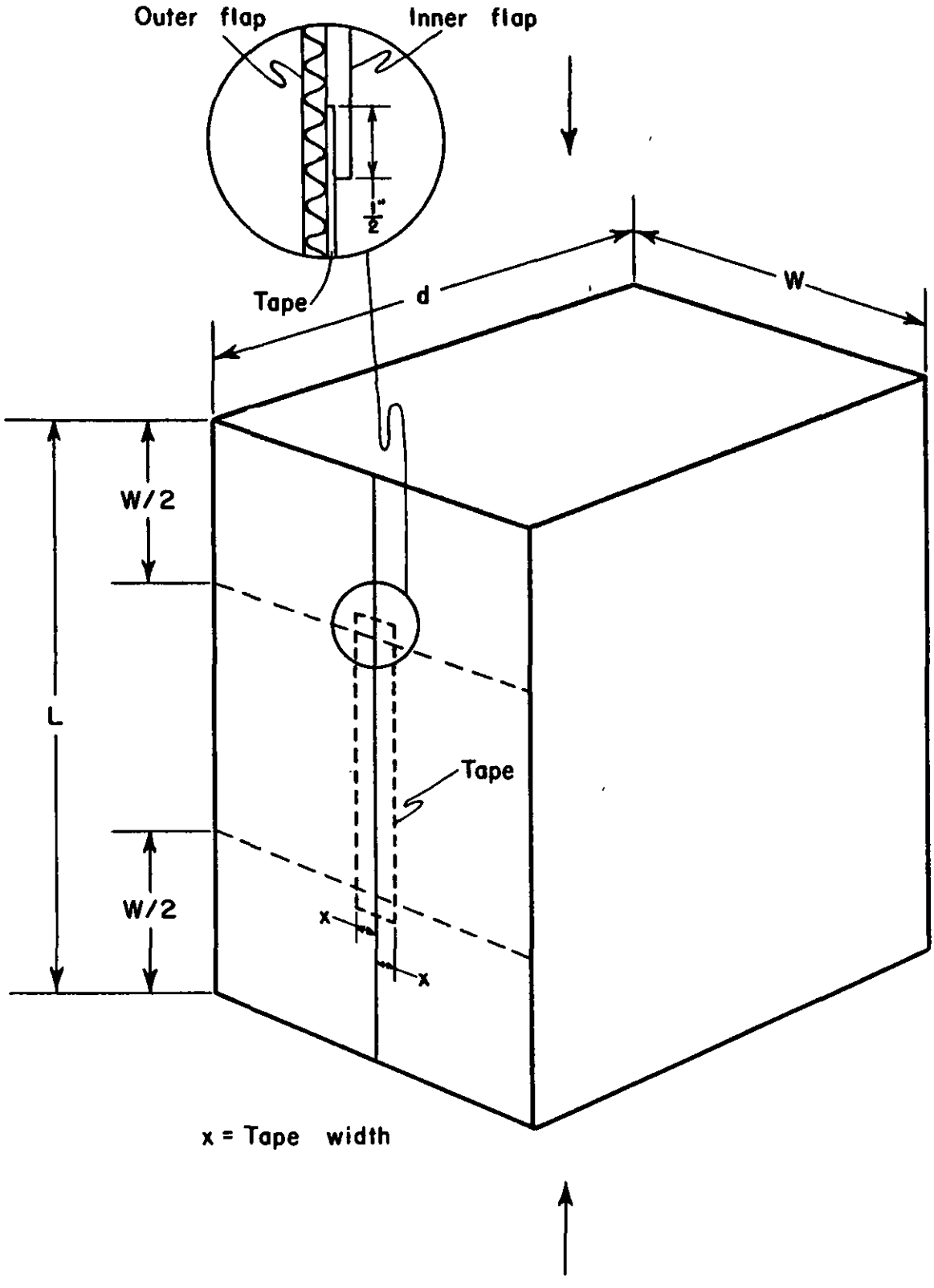

Figure 1. Tape Reinforcement of the Outer Flap of End-Load Boxes at the Middle of the Flap Panel.